Response to Te Ara Paerangi on behalf of NeSI

Who we are and why we are making a submission

a. This submission is from the leadership team and governance board for NeSI - National eScience Infrastructure. NeSI is an MBIE SSIF investment in partnership with University of Auckland, NIWA, University of Otago, and Manaaki Whenua.

b. NeSI collaborates with researchers in designing, building, and operating a specialised national platform of shared high performance computing and data (HPC) infrastructure and a rich range of eResearch expertise to meet and support varied needs of research.

c. NeSI's primary customers are researchers - NeSI better equips researchers to deliver new and valuable insights in their fields at local and global scales. NeSI works daily in direct support of and collaboration with researchers, and is more than simply an enabler.

d. NeSI's capabilities include computational power, research data management, training in computational thinking mindsets, skills, and tools, and in general expertise in developing advanced digital research capabilities. NeSI places an emphasis on being researcher-led, and focuses on scalable models for enabling change within the researcher workforce and research institutions.

e. NeSI are making this submission based on the last 10+ years as the peak national organisation and experts at delivering advanced eScience infrastructure, skills, and capabilities into the research sector. In this time NeSI have iterated on strategies, people, and infrastructure assets, with a focus on being responsive to the current and future needs of researchers in Aotearoa New Zealand. This role incorporates a global outlook and a concerted effort to identify and translate into practice the most relevant approaches developed in other research systems internationally.

f. NeSI by its nature navigates the complexities of institutional structures, funding and other incentives, and in the end how we achieve a critical mass of specialised digital research infrastructure to meet a broad church of needs. It is from this base of experience that we reflect here, not least to highlight the critical nature of advanced digital practice, technologies, and infrastructure as increasingly inseparable from a majority of research disciplines and scientific investigation.

Submitters

The submitters are the following groups who together represent the governance, leadership, and research advisor to NeSI - National eScience Infrastructure.

NeSI Senior Leadership Team

- Blair Bethwaite, Solutions Manager, NeSI, the University of Auckland
- Neil Bright, HPC Platforms Manager, NeSI, NIWA
- Nick Jones, Director, NeSI, the University of Auckland
- Dr Georgina Rae, Science Engagement Manager, NeSI, the University of Auckland
- Ruth Sowter, Business Operations Manager, NeSI, the University of Auckland
- Dr Jeff Zais, Science Advisor and HPC Architect, NeSI, NIWA

NeSI Research Reference Group

- Dr Joseph Lane (Chair) – Associate Professor, Physical & Theoretical Chemistry, University of Waikato
- Dr Jane Allison - Associate Professor, Biological Sciences, University of Auckland
- Prof. Blair Blakie – Department of Physics, University of Otago and Dodd-Walls CoRE Principal Investigator
- Dr Murray Cadzow, Programmer Scientific, Research and Teaching IT Support, University of Otago
- Dr Wolfgang Hayeh – Research Software Engineerm, NIWA, Wellington
- Prof. Cristin Print – Molecular Medicine & Pathology, University of Auckland; Associate Investigator, Maurice Wilkins CoRE; Team Member, Brain Research New Zealand
- Dr Nauman Maqbool – Group Leader of Knowledge & Analytics, AgResearch
- Prof. Ian Foster – Director of the Computation Institute, Argonne National Laboratory, University of Chicago, Illinois
- Prof. Barbara Chapman – Director of the Center for Advanced Computing and Data Systems, University of Houston, Texas; Professor of Applied Mathematics & Statistics and Computer Science, Stony Brook University, New York.

NeSI Board of Directors

- Rick Christie - Chair, Independent Director
- Prof. Amanda Barnard - Professor of Computational Science, Australian National University
- Dr Fiona Carswell - Chief Scientist, Manaaki Whenua - Landcare Research
- Dr David Eyers - Associate Professor of Computer Science, University of Otago
- Dr Kameron Christopher - Chief Scientist High Performance Computing and Data Science, NIWA
- Stephen Whideside - Chief Digital Officer, University of Auckland

What does good look like for the New Zealand research sector?

g. Digital technologies are disrupting every industry globally, including research. Over the decade ahead research sectors globally will continue to be transformed in major part by digital technologies and skills. Digitalisation makes the practices and artefacts of research explicit, and their gaps and weaknesses visible. Done well, it draws research practice back to its core principles - enabling collaboration and scale of mission, replication, external review, recording and sharing, and instrumentation - and in doing so provides greater rigour and enhanced quality, social licence, and impact.

h. NeSI's vision is of a highly connected and collaborative ecosystem of research, infused with advanced digital practice and powered by advanced computational and data infrastructures. Sector aspirations should recognise we have invested infrequently, and starting assumptions endure for a decade or more. Goals should be framed with at least a 10 year life in mind, and approaches adopted which ensure agility and responsiveness over these longer time horizons, with sustained investment in people and infrastructure, and explicitly defined goals and triggers for refreshing and scaling to support success.

i. In the specific context of eResearch Infrastructure, New Zealand's research system should aspire to address significant gaps in research artefact management, including national capabilities to support sensitive data and embrace Māori data sovereignty, support investment and maintenance of research software and its ethical use, and in each case with consideration for the needs of specific communities of use and kaitiakitanga or guardianship and principles of FAIR and CARE.

j. There should be nationally established data spaces or platforms similar to what has been realised through the Australian National Collaborative Research Infrastructure Strategy, and institutions need support for capability development in responding to these challenges. Rather than being a competitive advantage for the few, research data platforms should be common across research ecosystems and institutions, recognising that done well they are the primary medium of collaboration and sharing, and significantly lift productivity. Research communities should expect cultures of user centred codesign and appropriately open postures for access and participation, all of which need significant shifts in current priorities and investments to realise.

k. We should aspire to open pathways that encourage the emergence of new research communities that are yet to adopt digital technologies or transform their practices. Skills to use a wide range of digital tools should be seen as a desirable and accessible superpower for researchers, including high levels of adoption and use of scripting of software workflows and data cleaning and analysis as is supported through NeSI's training services including train the trainer and Carpentries. These programmes have

had a major impact over the last 5+ years, and are a validated model that could be scaled up and out with relatively modest levels of investment.

l. We need to have an operating model for research which enables a range of activities, moving from our current focus dominated by projects into a more sophisticated range of activity structures. We need an ability for ongoing programmes of research to be sustained, and for science products and services to be maintained on an ongoing basis, rather than through spurts and cross subsidies.

Area One

Nga whakaarotau rangahau / Research Priorities

m. Almost all areas of research require advanced digital technologies, across software or data capabilities, and the enabling skills acquisition and infrastructures. eResearch Infrastructures have a long heritage in physics, chemistry, and earth sciences going back almost 50 years, and these disciplines feature prominently in New Zealand's eResearch landscape of capable users. However the disciplines now driving eResearch has rapidly evolved in the last 10 years, and especially in the last 5. We're seeing rapid uptake across a broader range of disciplines with quite different challenges and needs.

n. Meanwhile investments and digitalisation across research disciplines internationally is creating a vast array of opportunities for these and other emerging disciplines of use, and in several areas of research priority for New Zealand our research teams are not operating on a level playing field with their international peers.

o. Any area of research priority likely requires technology partners and expertise to filter, acquire, and tailor eResearch technologies to fit their needs, and for mindful management of change through collaboration and co-design from the very start to ensure mutual success. NeSI has track record in supporting development of omics and other emerging communities. Meanwhile newer communities are aspiring to follow in these footsteps, including in environmental data and data science.

p. Digital research platforms are increasingly an enabler or a core capability of transdisciplinary research, and of working across the horizons of research. Digital workflows and platforms enable collaboration, knowledge sharing, and collective impact. Building these platforms isn't well supported by science projects alone - the mix of advanced eResearch expertise, co-designed infrastructure, and user-centred science needs all need combining through agile ways of working, and the goal is to support sustained delivery of value and incremental improvements and evolution in capabilities, together.

Area Two

Te Tiriti, Mātauranga Māori me ngā wawata o te Māori / Te Tiriti, Mātauranga Māori, and supporting Māori aspirations

q. NeSI is working alongside research teams that have invested in and are realising enduring partnerships with Māori. Through these partnerships NeSI is at the early stages of learning about and acquiring skills to operate in te ao Māori. Early insights and guidance from these Māori partners are valuing NeSI's culture and approaches with specific reference to NeSI's agility and user centricity. Alongside this are observations that NeSI needs to invest in its own relationships with Māori, and enrich its culture and capabilities to support this. While NeSI is recognised as carrying its engagements authentically and with humility, our aspiration for national eResearch infrastructure and capability needs to reach far further, deeper into communities and more broadly in terms of its partnerships.

r. Specific areas of contribution could see NeSI becoming capable of supporting Māori data sovereignty, and of providing upskilling in partnership with Māori researchers and in relevant communities of use, building on successes of programmes like the Carpentries through tailoring resources to fit the needs and goals of specific Māori communities. NeSI has built strong foundations in partnership with Genomics Aotearoa and the Rakeiora Pathfinder terms, through work on data repositories in support of taonga species genomics, and with Māori community led supprot for clinical genomics. This lays a foundation for enabling of a range of future potential data platforms, and exploring more impactful forms of federation, distribution, and delegation of governance and priority setting. There is potential to significantly improve support for development of the Maori economy informed by science/research/Mātauranga Māori in a digital medium, with a co-governance context.

Area Three

Te tuku pūtea / Funding

s. In order to achieve the Government's longer term goals of lifting research funding to comparable levels with other small advanced economies with the OECD requires a doubling to tripling of current spend in terms of % of GDP, which equates to another $NZD 3 - 6B per annum. While private industry in New Zealand carries far lower contribution than comparator countries, lifting that segment's contribution would require a long term structural adjustment to the economy that isn't likely achievable within the time frames signalled.

t. As a component of the Crown investment in research, research infrastructure is likewise significantly under funded on an international benchmark as acknowledged in the Green Paper. There are many deserving opportunities for potential investment in research infrastructure. Among many, the digital or eResearch infrastructures are the most widely applicable across areas and horizons of science, and present some of the most inclusive and transformative potential.

u. Meanwhile funding of people is essential alongside investments into instruments and assets - we need the people to make them work, we need the people to support and upskill the researchers, we need the people looking at broader capability build and partnering. Too often these roles are seen as technician/operator roles, and not recognised for the impact they have, through technology adoption and diffusion, and through maintaining good service levels and productivity in science.

7. How should we determine what constitutes a core function and how do we fund them?

v. As a small country we shoudl invest at a national scale to provide equality of access sector wide. NeSI currently operates under a Club model based on coinvestment provided by a few institutions. NeSI could operate as a core function in a non-competitive position as a shared platform, able to support a wide range of returns and impacts. It's focus on capability building, or taking resources and improving them for a broader range of use cases, is key.

8. Do you think a base grant funding model will improve stability and resilience for organisations? How should we go about designing and implementing such a funding model?

A stable environment for national eResearch infrastructure is crucial, with change managed well, underpinned by co-design based on sustainable long-term partnerships.

Area Four

Ngā hinonga / Institutions

w. NeSI is unincorporated - as a collaboration it operates across four research institutions - two universities, two Crown Research Institutes. The people and assets which comprise the core resources under NeSI's management are employed at and owned by one or other of its collaborators. Research sector institutional strategies and investment behaviours are primarily driven by an institution's core mandate, and effective governance aligns the organisation in that direction. There are a wide range of successes working collaboratively across institutions. In some cases these collaborations come closer to an institution's core mandate or sense of identity or opportunity, and in these situations entering into collaborations carries higher risk.

9. How do we design collaborative, adaptive and agile research institutions that will serve our current and future needs?

x. While National Science Challenges and other super-institutional structures are maturing, they operate in tension with institutional autonomy, receiving a mixed review. If the goal is greater degrees of collaboration, governance and leadership principles and cultures across the sector should be primed to enable collaborative and shared approaches. Collaborations are most successful when all parties adopt a generous posture towards any collaboration, bring opportunities to the collaboration first, and create working environments with minimal intrinsic conflict.

y. Institutional operating models are commonly project based, with projects critically dependent on short lived funding and resourcing defined within a project life cycle. This operating model was proposed in the early 1990's and is now highly optimised. It is also at odds with modern industry practice, where most organisations are adopting agile ways of working, ensuring job security for staff while embedding cultures and ways of working which aid flexibility, adaptation, learning, and responsiveness.

z. We need investment into stability for staff alongside learning and training of an agile workforce. A variety of operating models are possible on top of NeSI - we need to evolve from a singular focus on projects to incorporate longer running programmes, short to long term lifecycles, and collaborations around products or services which don't neatly fit into an existing box.

aa. Core tenants of such cultures are psychological safety and self selection. A measure of this is the degree to which researchers of all career stages and those in related roles are

at the table shaping research directions, goals, and measures of success, within and beyond an organisation's formal boundaries.

bb. NeSI needs an organisational structure, operating model, and culture fit for the next 10+ years, and the flexibility to learn, evolve, and adapt in response to its own core purpose. NeSI has a core role in enabling equality of access. Currently this is diminished by competition based on local investment into underpinning computing/data resources, rather than national approaches to enabling platforms of computing and data, skills, a focus on digital as a common good for all researchers.

Area Five

Te hungu nahi rangahau / Workforce

cc. There are essential pressures on a research workforce in need of advanced digital skills across a wide spectrum of research disciplines and horizons.
There are key questions to be addressed on how we support cross cutting capabilities in various areas e.g. data science, Research Software Engineering career paths, etc. How do we support and sustain these capabilities? Maori leadership is essential to be included in development of an eResearch workforce - Maori must have the skills to work on their needs, and eResearch can help to enable this.

Area Six

Te hanganga rangahau / Research infrastructure

dd. Most advanced economies made initial national investments into digital research infrastructure during the decade beginning in the late 1960's. Core digital technologies such as the Internet (the sophomore advanced research network), the World Wide Web, High Performance Computing, Email, and many others emerged as a direct result of the first two decades of these investments, and these nations have gone on to build a deep and abiding connection between research and digital technologies.

ee. New Zealand's research sector made brief investments in an advanced research network and high performance computing for research in the late 1980's. The network lay the foundations for connecting New Zealand to the Internet, yet in each case a failure to sustain investment over the short term saw the research use of these technologies languish. It would be 25 years before subsequent national investments were hard won, starting with REANNZ and the KAREN network in 2006, and followed by NeSI in 2011.

ff. Over the last 10+ years NeSI have iterated on strategies, people, and infrastructure assets, with a focus on being responsive to the current and future needs of researchers in Aotearoa New Zealand. NeSI by its nature navigates the complexities of institutional structures, funding and other incentives, and in the end how we achieve a critical mass of specialised digital research infrastructure to meet a broad church of needs.

gg. There is clear evidence that New Zealand researchers are well served by these eResearch infrastructures (REANNZ, NeSI), and that their value propositions are proven. New Zealand has done well to rapidly acquire these eResearch capabilities, learning from long histories globally and translating these into use locally.

hh. Meanwhile other advanced economies have invested in a far broader scope of digital research capabilities, and in a planned and rapid transformation of research practice through eResearch capabilities. Looking to Canada and their newly formed Digital Research Alliance is a source of inspiration for what good might look like, not least due to how similar their Needs Assessment suggests their situation might be to our own (despite differences in scale).

ii. There are glaring gaps in New Zealand's investments into digital research skills and eResearch infrastructure, with scale and scope of current investments based on initially conservative assumptions that are at least a decade old. We have a once in a decade opportunity to reformulated our investments based on where we are today, and more importantly where we might be in a decade hence.

jj. NeSI is currently into its third extension of its second 4-year MBIE head contract, with the extension overhanging the end of this contract by a further 5 years. NeSI is into its 11th year, and there is a need to establish a stable and sustainable ongoing model for

NeSI. NeSI anticipates going through a consultative process in alignment with the eResearch Report commissioned by MBIE to formulate our future plans, not least to develop a business case for ongoing MBIE support from the end of its current contract in mid-2023.

17. How do we support sustainable, efficient and enabling investment in research infrastructure?

kk. The co-investment model for research infrastructure appears to operate well in some circumstances, where all parties involved in using a common good are able to participate in funding and using it. When a far broader level of participation is anticipated, and a medium term expectation that the mix and scale of participation is dynamic, co-investment clubs appear to break down. Not all participants can afford to become members, and few desire to until their needs are well understood. This creates dual tensions of free riding and of friction which inhibits inclusion and broader adoption. eResearch Infrastructure fits firmly at this end of the spectrum. While the club model was most likely an appropriate place to catalyse an initial investment, it's been clear for some time this is no longer the case.

ll. NeSI has been a success in major part due to its focus on high quality people, who are both experts in their field and also carry cultures amenable to collaboration and service. While the core infrastructure assets have been an important enabler, the impact of the people reaches far broader. The two do go hand in hand, as without the core infrastructure on which to apply their expertise, these experts would be severely constrained in their ability to respond to researchers' needs. These people aren't just the operators of the infrastructure, they're working across the value chain in delivering added value in terms of eResearch skills, and more sophisticated eResearch capabilities and services within operational partnerships alongside research teams. Where we invest in infrastructure assets and operations alone, we should complement such with investments in capability building - not doing so creates significant drag in realising benefits and impacts from research infrastructure investments.

mm. There are key gaps in the scope of eResearch infrastructure currently, notably in research data management, software and data engineering, and as an integrated component of national investments in specific aspects of science including data sciences, environmental and earth sciences, and biomedical and biological sciences. NeSI's scope was formulated in 2010 based on the preceding 5 years of research community development and discovery of national needs for traditional high performance computing and basic data management.

nn. The last decade has seen a significant growth in the diversity of communities needing advanced research computing infrastructure, tools, and skills, and integrated domain

specific solutions. While there are leading exemplars especially in areas of genomics and climate science, there is significant inertia in supporting and growing new communities of use. In the current exemplars, NeSI has needed to retain specialised skills with first hand knowledge of specific disciplinary needs, to ensure technologies are pulled into communities through empathetic user centred and co-design approaches. Addressing additional communities requires a sophisticated balancing of infrastructure and people, and sustained investment into enduring long term relations.

oo. There are a range of other specific needs, including support for:

- Research Software Engineer career paths, scaling up training and train the trainer programmes,
- research data platforms e.g. environmental, data science, biomedical, Maori data spaces,
- Leveraging public and private Cloud platforms - exploring a hybrid balance of sovereign national and commercial clouds, brokering as a trusted advisor, and establishing the essential attributes of cost control, environment/workflow/data life cycle management, and overall skilled operations to make good efficient cost effective use,

pp. Meanwhile the scale of current investments is limiting potential for a more inclusive broad ranging level of participation and impact, and leaving institutions and communities chasing their own local investments at the opportunity cost of critical mass and progress nationally towards more ambitious goals. Other countries are creating strong incentives for research teams to operate higher up the value chain, providing incentives for coordinating and consolidating core physical computing and data infrastructures - the Canadian Digital Research Infrastructure Alliance is a progressive example of this, providing direct funding for the operations and support of contributed computing and data assets owned by institutions and communities, in exchange for these assets contributing to the national pool and thereby growing scale and critical mass in core eResearch infrastructure.